# EVALUATION OF ATMOSPHERIC IMPACTS OF SELECTED COATINGS EMISSIONS


BY

WILLIAM P. L. CARTER

COLLEGE OF ENGINEERING CENTER FOR
ENVIRONMENTAL RESEARCH AND TECHNOLOGY
UNIVERSITY OF CALIFORNIA, RIVERSIDE


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## OUTLINE

**BACKGROUND**

- QUANTIFICATION OF REACTIVITY AND EXAMPLES
- UNCERTAINTIES IN REACTIVITY SCALES

**REACTIVITY RESEARCH NEEDS FOR ARCHITECTURAL COATINGS**

**COMPONENTS OF CE-CERT COATINGS PROJECT PROPOSED TO THE CARB**

# VOC REACTIVITY

VOCs DIFFER IN THEIR EFFECTS ON OZONE FORMATION.  THE TERM **REACTIVITY** IS USED TO REFER TO THIS.

SEVERAL DIFFERENT ASPECTS OF A VOCs ATMOSPHERIC REACTIONS AFFECT ITS REACTIVITY:

- HOW FAST IT REACTS.
- HOW MUCH O3 IS FORMED DIRECTLY FROM ITS REACTIONS AND THOSE OF ITS PRODUCTS.
- WHETHER IT ENHANCES OR INHIBITS ATMOSPHERIC RADICAL LEVELS. THIS AFFECTS HOW FAST $O_3$ IS FORMED FROM ALL VOCs.
- WHETHER IT ENHANCES RATES $NO_x$ REMOVAL. THIS AFFECTS ULTIMATE $O_3$ YIELDS BECAUSE NOx IS REQUIRED FOR $O_3$ TO BE FORMED.

**A VOC's EFFECT ON $O_3$ ALSO DEPENDS ON THE NATURE OF THE ENVIRONMENT WHERE IT REACTS.**

# QUANTIFICATION OF REACTIVITY

A USEFUL MEASURE OF THE EFFECT OF A VOC ON OZONE FORMATION IS **INCREMENTAL REACTIVITY**:

$$\begin{bmatrix}\text{INCREMENTAL}\\ \text{REACTIVITY}\\ \text{OF A VOC IN}\\ \text{AN EPISODE}\end{bmatrix} = \lim_{[\text{voc}]\to 0} \frac{\begin{bmatrix}\text{OZONE}\\ \text{FORMED}\\ \text{WHEN VOC}\\ \text{ADDED TO}\\ \text{EPISODE}\end{bmatrix} - \begin{bmatrix}\text{OZONE}\\ \text{FORMED}\\ \text{IN AN}\\ \text{EPISODE}\end{bmatrix}}{\begin{bmatrix}\text{AMOUNT OF VOC}\\ \text{ADDED TO EMISSIONS}\\ \text{IN THE EPISODE}\end{bmatrix}}$$

**THIS DEPENDS ON THE CONDITIONS OF THE EPISODE AS WELL AS ON THE VOC**

# MEASUREMENT OR CALCULATION OF ATMOSPHERIC REACTIVITY

REACTIVITY CAN BE MEASURED IN ENVIRONMENTAL CHAMBER EXPERIMENTS. BUT THE RESULTS ARE NOT THE SAME AS REACTIVITY IN THE ATMOSPHERE.

- NOT PRACTICAL TO EXPERIMENTALLY DUPLICATE ALL ATMOSPHERIC CONDITIONS AFFECTING REACTIVITY
- CHAMBER EXPERIMENTS HAVE WALL EFFECTS, USUALLY HIGHER LEVELS OF NOx AND ADDED TEST VOC, STATIC CONDITIONS, ETC.

ATMOSPHERIC REACTIVITY MUST BE CALCULATED USING COMPUTER AIRSHED MODELS, GIVEN:

- MODELS FOR AIRSHED CONDITIONS
- CHEMICAL MECHANISMS FOR THE VOC's ATMOSPHERIC REACTIONS

**CALCULATIONS OF ATMOSPHERIC REACTIVITY CAN BE NO MORE RELIABLE THAN THE CHEMICAL MECHANISM USED.**

ENVIRONMENTAL CHAMBER EXPERIMENTS ARE USED TO TEST THE RELIABILITY OF MODELS TO PREDICT ATMOSPHERIC REACTIVITY.

# EXAMPLES OF WAYS TO DEAL WITH THE DEPENDENCE OF REACTIVITY ON ENVIRONMENTAL CONDITIONS

BASE THE SCALE ON A "REPRESENTATIVE" OR "WORST CASE" EPISODE.

- MAY NOT BE OPTIMUM FOR ALL CONDITIONS.

USE MULTIPLE SCALES REPRESENTING THE RANGE OF APPLICABLE CONDITIONS.

- ALLOWS AN ASSESSMENT OF EFFECTS OF VARIABILITY.
- BUT NOT USEFUL WHEN A SINGLE SCALE IS REQUIRED.

BASE THE SCALE ON CONDITIONS WHERE VOCs HAVE MAXIMUM INCREMENTAL REACTIVITIES (**MIR SCALE**).

- REFLECTS URBAN CONDITIONS WHERE OZONE IS MOST SENSITIVE TO VOC EMISSIONS
- GIVES GOOD CORRELATIONS TO EFFECTS OF VOCs ON INTEGRATED OZONE EXPOSURE.
- BUT DOES NOT REPRESENT CONDITIONS WHERE HIGHEST OZONE CONCENTRATIONS ARE FORMED.

# EXAMPLES OF RELATIVE REACTIVITIES AT DIFFERENT $NO_x$ LEVELS

OZONE IMPACTS PER GRAM VOC / OZONE IMPACT PER GRAM OF AMBIENT VOC MIXTURE.

| COMPOUND OR MIXTURE | MAX. VOC IMPACT (MIR) (HIGH $NO_x$) | $NO_x$ GIVING MAXIMUM OZONE | $NO_x$ & VOC IMPACTS EQUAL (LOW $NO_x$) |
|---|---|---|---|
| ETHANE | 0.08 | 0.14 | 0.17 |
| ALL-ALKANE MINERAL SPIRITS | 0.21 | 0.33 | 0.30 |
| TEXANOL | 0.24 | 0.32 | 0.33 |
| ETHYL BENZENE | 0.75 | 0.69 | 0.50 |
| M-XYLENE | 2.9 | 2.2 | 1.8 |
| AMBIENT VOC MIXTURE | 1 | 1 | 1 |

# UNCERTAINTIES IN REACTIVITY SCALES

## UNCERTAINTY IN THE GENERAL APPLICABILITY OF ANY SINGLE SCALE

- NO SCALE CAN REPRESENT ALL ENVIRONMENTS.
- NOT ALL EXPERTS AGREE THAT THE MIR SCALE IS THE MOST APPROPRIATE FOR REGULATIONS.
- CALIFORNIA HAS ADOPTED THE MIR SCALE. THE EPA WANTS MORE RESEARCH BEFORE ADOPTING A SCALE FOR REGULATIONS.

## CHEMICAL MECHANISM UNCERTAINTY

- GENERAL MECHANISM UNCERTAINTIES CAUSE UNCERTAINTY FOR EVEN WELL-STUDIED VOCs.
- UNCERTAINTIES ARE MUCH GREATER FOR VOCs WITH NO DATA TO VERIFY THEIR MECHANISMS.

## COMPOSITION UNCERTAINTY

- APPLICABLE TO COMPLEX MIXTURES SUCH AS VEHICLE EXHAUSTS AND PETROLEUM DISTILLATES

## MECHANISM UNCERTAINTY CLASSIFICATION AND MINIMUM UNCERTAINTY ESTIMATES FOR RELATIVE MIR SCALE

| NO. | DESCRIPTION | MIN. UNC'Y |
|---|---|---|
| 1 | MECHANISM NOT EXPECTED TO CHANGE SIGNIFICANTLY | 15% |
| 2 | SOME UNCERTAINTIES BUT MECHANISM ADEQUATELY TESTED | 15% |
| 3 | ESTIMATED MECHANISM BASED ON DATA FOR SIMILAR COMPOUNDS | 30% |
| 4 | ESTIMATED MECHANISM BASED ON UNCERTAIN ASSUMPTIONS | 75% |
| 5,6 | MECHANISM OR ESTIMATE IS HIGHLY SIMPLIFIED OR MAY BE INCORRECT | 100% |

**NOTE:**

- MINIMUM UNCERTAINTIES SHOWN ARE **HIGHLY APPROXIMATE AND SUBJECTIVE**
- UNCERTAINTIES SHOWN ARE FOR **RATIOS** OF MIRs
- UNCERTAINTIES IN **ABSOLUTE** OZONE IMPACTS ARE MUCH HIGHER

## EXAMPLE SOLVENT VOCs WITH VARIOUS MECHANISM UNCERTAINTY ASSIGNMENTS

| NO. | EXAMPLES | MIN. UNC'Y |
|---|---|---|
| 1 | METHANOL, ACETALDEHYDE[A], 1-METHOXY-2-PROPANOL[B] | 15% |
| 2 | ETHYLENE GLYCOL, ETHYLBENZENE, 1-METHOXY-2-PROPYL ACETATE[C] | 15% |
| 3 | $C_{8+}$ ALKANES[D], MOST GLYCOLS, GLYCOL ETHERS, ESTERS, ETC.[E] | 30% |
| 4 | $C_{13}$ NAPHTHALENES, FURAN, $C_{3+}$ ACETYLENES[D] | 75% |
| 5,6 | AMINES, OXIMES, HALOGENATED COMPOUNDS, OXIMES, ETC.[E] | 100% |

**NOTES:**

[A] SIMPLE, WELL-ESTABLISHED MECHANISMS

[B] RELEVANT REACTION ROUTES WELL-ESTABLISHED BY LABORATORY STUDIES

[C] ENVIRONMENTAL CHAMBER DATA USED TO VERIFY OR DERIVE MECHANISMS

[D] MIRs SENSITIVE TO GENERAL MECHANISM UNCERTAINTIES

[E] MECHANISM UNKNOWN OR VERY UNCERTAIN

# EXAMPLES OF COMPOSITIONAL UNCERTAINTY FOR COMPLEX MIXTURES

| COMPONENT | MIR UNC'Y |
|---|---|
| **ALL-ALKENE PETROEUM DISTILLATES** | |
| • MINIMAL INFORMATION GIVEN | ~33% |
| • CARBON NUMBER DISTRIBUTIONS KNOWN | ~17% |
| • FRACTIONS OF NORMAL AND TOTAL BRANCHED AND CYCLIC ALSO KNOWN | 0% |
| **MIXTURES OF AROMATICS** | |
| • MINIMAL INFORMATION GIVEN | ~60% |
| • CARBON NUMBER DISTRIBUTIONS KNOWN | ~55% |
| • FRACTIONS OF MONO-, DI-, AND POLY-SUBSTITUTED BENZENES AND NAPHTHALENES ALSO KNOWN | 0% |
| **OTHERS** | |
| • UNSPECIFIED GLYCOL ETHERS | ~30% |
| • PETROLEUM DISTILLATE WITH AROMATIC FRACTION NOT SPECIFIED | ~100% |

## EXAMPLE WORKSHEET TO ESTIMATE OZONE IMPACTS OF A FORMULATION

| COMPONENT | GM /LITER | MIR (GM $O_3$ / GM) | MIR UNC'Y COMP | MIR UNC'Y MECH | $O_3$ FORM. (GM $O_3$ / LITER) |
|---|---|---|---|---|---|
| ALKANE MIX | 100 | 0.85 | 15% | 30% | 85 $\pm$ 29 |
| AROMATIC MIX | 10 | 6.4 | 50% | 30% | 64 $\pm$ 37 |
| TEXANOL | 20 | 0.89 | 0 | 30% | 18 $\pm$ 5 |
| AMINE | 5 | ~7 | 0 | 100% | 35 $\pm$ 35 |
| UNIDENTIFIED VOCs | 2 | ~4 | 200% | | 8 $\pm$ 16 |
| WHOLE FORMULATION | | | | | 210 $\pm$ 61 |

# ADDITIONAL INFORMATION AVAILABLE

## REACTIVITY RESEARCH WORKING GROUP

**http://www.cgenv.com/narsto/reactinfo.html**

- MISSION STATEMENT
- REACTIVITY POLICY WHITE PAPER
- REACTIVITY SCIENCE ASSESSMENT DOCUMENTS

## REACTIVITY DATA AND DOCUMENTATION

**http://www.cert.ucr.edu/~carter/reactdat.htm**

- TABULATION OF MIR, OTHER REACTIVITY SCALES
- REPORT DOCUMENTING CHEMICAL MECHANISM AND METHODS USED TO CALCULATE REACTIVITY
- LINKS TO OTHER REPORTS AND PRESENTATIONS CONCERNING W.P.L. CARTER'S RESEARCH

# REACTIVITY RESEARCH NEEDS FOR VOCs FOR ARCHITECTURAL COATINGS

REACTIVITY DATA ARE ALREADY AVAILABLE FOR MANY TYPES OF VOCs USED IN COATINGS

- DATA AVAILABLE FOR REPRESENTATIVE ALKANES, AROMATICS, ALCOHOLS, GLYCOLS, ESTERS, ESTERS AND A FEW OTHERS.
- BUT NOT ALL ASPECTS OF MECHANISMS ARE ADEQUATELY EVALUATED.

REACTIVITY ESTIMATES ARE UNCERTAIN FOR SOME IMPORTANT TYPES OF COATINGS VOCs

- NO DATA FOR LOW VOLATILITY COMPOUNDS SUCH AS TEXANOL
- PETROLEUM DISTILLATES HAVE LARGE COMPOSITIONAL UNCERTAINTY
- COATINGS INCLUDE COMPOUNDS WITH VERY UNCERTAIN REACTIVITY ESTIMATES
  - UNSATURATED OXYGENATES SUCH AS VINYL ACETATE AND ACRYLATES.
  - AMINES AND ALCOHOL AMINES

NEED TO DEVELOP LOWER COST REACTIVITY SCREENING AND ENFORCEMENT METHODS

UNCERTAIN HOW MUCH DEPOSITION ON SURFACES AND OTHER NON-ATMOSPHERIC LOSS PROCESSES ARE AFFECTING ATMOSPHERIC AVAILABILITY

# COMPONENTS OF CE-CERT COATINGS PROJECT FOR THE CARB

CONDUCT EMISSIONS, REACTIVITY AND UNCERTAINTY SURVEY OF COATINGS VOCs TO PRIORITIZE RESEARCH

CONDUCT ENVIRONMENTAL CHAMBER STUDIES OF SELECTED COATINGS VOCs USING "NEXT GENERATION" CHAMBER BEING DEVELOPED FOR THE EPA

APPLY A DIRECT REACTIVITY SCREENING METHOD TO LOW VOLATILITY VOCs, PETROLEUM DISTILLATES, OTHER COATINGS CONSTITUENTS

DEVELOP AND EVALUATE IMPROVED PROCEDURES TO QUANTIFY REACTIVITIES AND COMPOSITIONAL UNCERTAINTIES FOR PETROLEUM DISTILLATES

**HOWEVER, AVAILABLE FUNDING NOT SUFFICIENT TO DO ALL THE WORK NEEDED IN THESE AREAS.**

# PRELIMINARY RESULTS OF SURVEY OF COATINGS EMISSIONS REACTIVITY

## VOCs IN DRAFT COATINGS INVENTORY FOR WHICH REACTIVITY DATA ARE UNAVAILABLE

| MIR x EMIT | TYPE OF VOC | MECH UNC'Y |
|---|---|---|
| | **WATER BASED COATINGS** | |
| ~10% | Texanol | 3 |
| ~5% | Vinyl Acetate | 5 |
| ~5% | Butyl Carbitol | 3 |
| ~3% | Various Petroleum Distillates | - |
| ~1% | Methyl Carbitol | 3 |
| ~0.5% | Diethylene Glycol | 3 |
| ~0.5% | Di (propylene glycol) Methyl Ether | 3 |
| ~0.5% | 2-Amino-2-Methyl-1-Propanol | 6 |
| ~25% | UNCERTAIN VOC TOTAL | |
| | **SOLVENT BASED COATINGS** | |
| ~50% | Various Petroleum Distillates | - |
| ~1% | n-Butyl Alcohol | 3 |
| ~0.5% | Ethyl 3-Ethoxypropionate | 3 |
| ~50% | UNCERTAIN VOC TOTAL | |

# ENVIRONMENTAL CHAMBER STUDIES OF SELECTED COATINGS VOCs

**VOCs WILL BE CHOSEN BASED ON RESULTS OF SURVEY**

- TEXANOL APPEARS TO BE A PRIORITY, BUT VINYL ACETATE SHOULD ALSO BE CONSIDERED

**NEW LARGE ENVIRONMENTAL CHAMBER BEING DEVELOPED FOR THE EPA WILL BE EMPLOYED**

- CONSTRUCTED AND EVALUATED USING ~$3 MILLION FUNDING FROM CONGRESS
- CAN OBTAIN DATA AT LOWER CONCENTRATIONS THAN PREVIOUSLY POSSIBLE
  - MORE REPRESENTATIVE OF CURRENT AMBIENT ATMOSPHERES
  - EASIER TO STUDY LOW VOLATILITY VOCs
- INSTRUMENTATION FOR MORE COMPREHENSIVE CHEMICAL ANALYSIS
- INSTRUMENTATION FOR INFORMATION ON AEROSOL (PM) IMPACTS

**METHODS FOR STUDIES OF LOW VOLATILITY VOCs WILL BE INVESTIGATED IF NEEDED**

**BECAUSE OF LIMITED FUNDING, ONLY A SINGLE COMPOUND CAN BE STUDIED**

## U.C. RIVERSIDE CHAMBER FACILITY PROGRESS AND CURRENT STATUS

INTERNATIONAL WORKSHOP ON ATMOSPHERIC CHEMISTRY AND ENVIRONMENTAL CHAMBER RESEARCH HELD IN OCTOBER, 1999

EXPERIMENTS UNDERWAY TO INVESTIGATE AND MINIMIZE BACKGROUND EFFECTS USING SMALLER (~3000-LITER) REACTORS

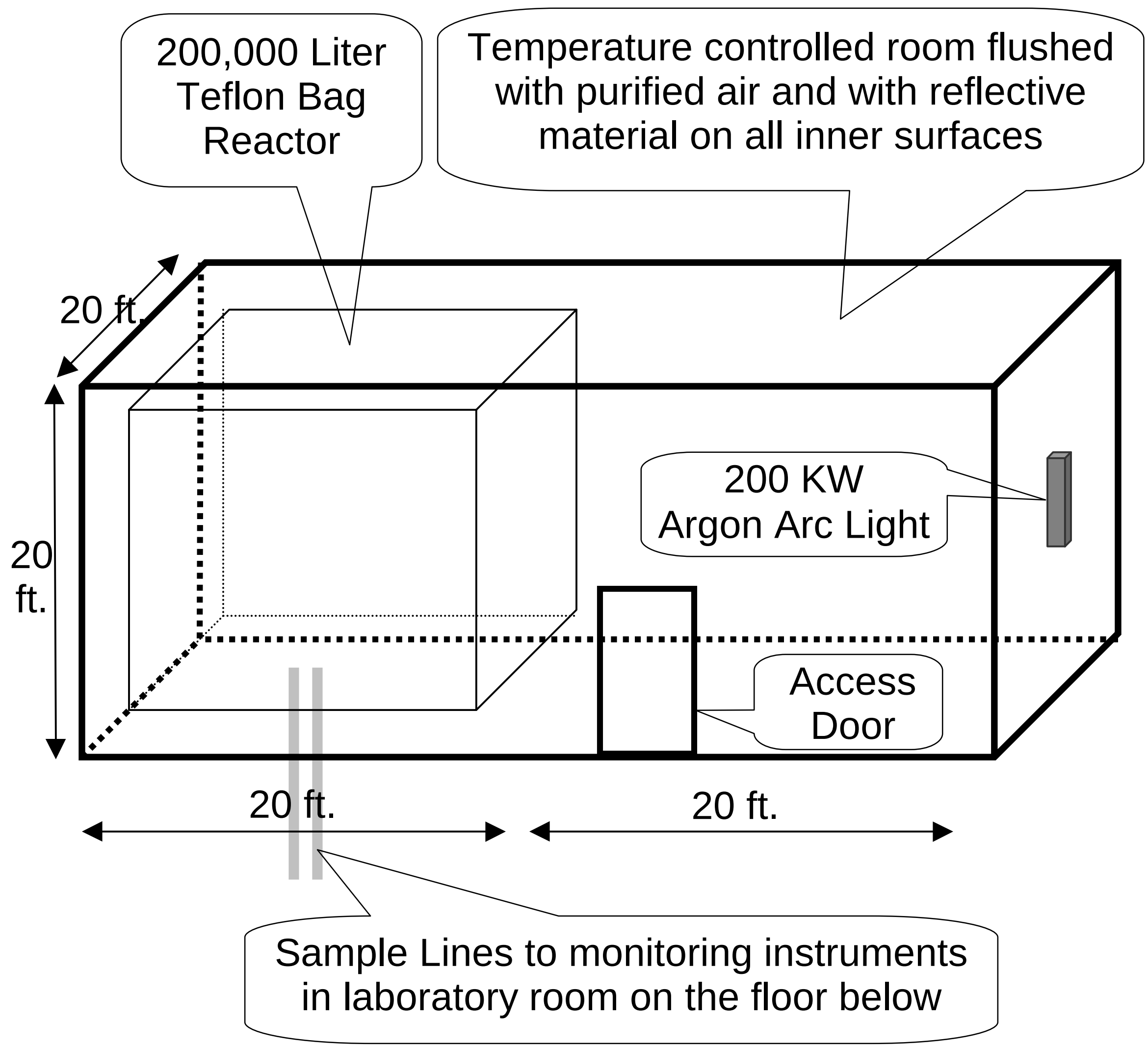
- VARIOUS TYPES OF WALL MATERIAL TESTED
- BACKGROUND $NO_x$ OFFGASING ~1 PPB/DAY

OBTAINING INSTRUMENTATION MOST NEEDED FOR ASSESSING LOW $NO_x$ EFFECTS

DESIGN AND CONSTRUCTION OF CHAMBER AND LIGHT SOURCE FACILITY

- DESIGN WORK COMPLETED
- NEW BUILDING BEING CONSTRUCTED. ESTIMATED COMPLETION MARCH, 2001
- 200,000-LITER TEFLON BAG REACTOR(S) WILL BE IN “CLEAN ROOM” FLUSHED WITH PURE AIR
- 200 KW ARGON ARC LIGHT WILL SIMULATE SUNLIGHT SPECTRUM AND INTENSITY
- TEMPERATURE CONTROL FROM 4 - 50$^o$C (40 - 120$^o$F) TO $\pm$1$^o$C ($\pm$2$^o$F)
- EXPECTED TO BE OPERATIONAL IN MAY, 2001

# DIAGRAM OF ENVIRONMENTAL CHAMBER AND TEMPERATURE-CONTROLLED ENCLOSURE



# DEVELOPMENT AND APPLICATION OF DIRECT REACTIVITY SCREENING METHOD

## DIRECT REACTIVITY

- THIS IS THE RATE A VOC REACTS AND OXIDIZES NO, WHICH IS THE PROCESS THAT FORMS $O_3$
- THIS IS ONE OF SEVERAL FACTORS AFFECTING REACTIVITY. THIS MAY BE MORE IMPORTANT IN THE ATMOSPHERE THAN IN CHAMBER STUDIES.
- MEASURES OF DIRECT REACTIVITY WILL GIVE MORE COMPLETE MECHANISM EVALUATION AND CAN TEST UNCERTAIN REACTIVITY ESTIMATES.

## OBJECTIVES

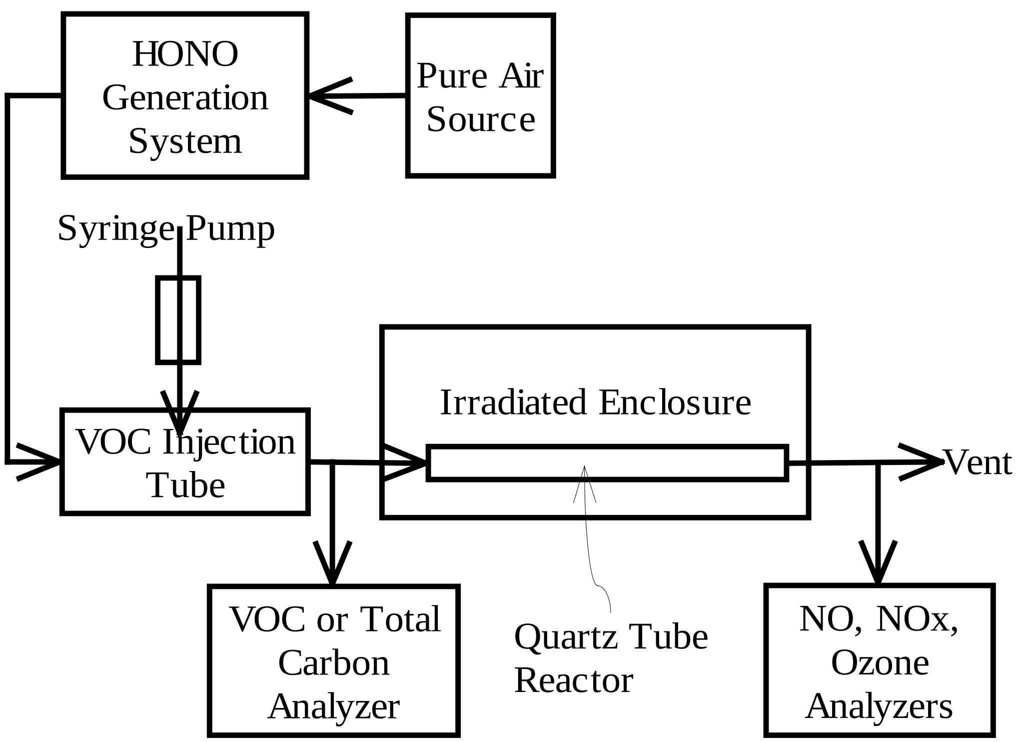
- DEVELOP A MEANS TO MEASURE DIRECT REACTIVITY THAT IS LESS EXPENSIVE AND AMBIGUOUS THAN CHAMBER STUDIES.
- ADAPT THE METHOD SO IT CAN BE USED FOR LOW VOLATILITY COMPOUNDS AND FOR COMPLEX MIXTURES.
- APPLY THE METHOD TO TEST MECHANISMS OF SELECTED VOCs
- APPLY METHOD TO TEST REACTIVITY ESTIMATION METHODS FOR PETROLEUM DISTILLATES
- APPLY METHOD TO TEST REACTIVITY ESTIMATION METHODS FOR WHOLE SOLVENTS OR COATINGS?

# PRINCIPLE OF DIRECT REACTIVITY MEASUREMENT METHOD

## PHOTOLYSIS OF NITROUS ACID (HONO) IN THE PRESENCE OF ADDED VOC IN AIR

- IN ABSENCE OF ADDED VOC, HONO/AIR PHOTOLYSIS FORMS MAINLY NO AND $NO_2$
- ADDED VOC CAUSES NO TO DECREASE AND $O_3$ TO BE FORMED IF ALL THE NO IS CONSUMED
- CHANGE IN $[O_3]$-[NO] CAUSED BY ADDING VOC IS THE MEASURE OF DIRECT REACTIVITY

## FLOW SYSTEM EMPLOYED



# CURRENT STATUS OF WORK ON DIRECT REACTIVITY MEASUREMENT METHOD

METHOD BEING DEVELOPED FOR AN EXISTING CARB CONTRACT THAT ENDS IN 12/2001

METHOD TESTED SUCCESSFULLY WITH N-ALKANES THROUGH N-C16.

NEED TO TEST REPRODUCIBILITY OF THE METHOD AND APPLICABILITY TO OTHER COMPOUNDS.

SYRINGE PUMP INJECTION METHOD MAY PERMIT EVALUATION OF COMPLEX MIXTURES AND LOW VOLATILITY MATERIALS

NEED TO DEVELOP TOTAL CARBON ANALYSIS METHOD FOR COMPLEX MIXTURES AND LOW VOLATILITY MATERIALS

# WORK FOR PROPOSED PROGRAM

AMOUNT OF DEVELOPMENT WORK REQUIRED ON COATINGS PROGRAM WILL DEPEND ON STATE OF PROGRESS WHEN EXISTING CONTRACT ENDS.

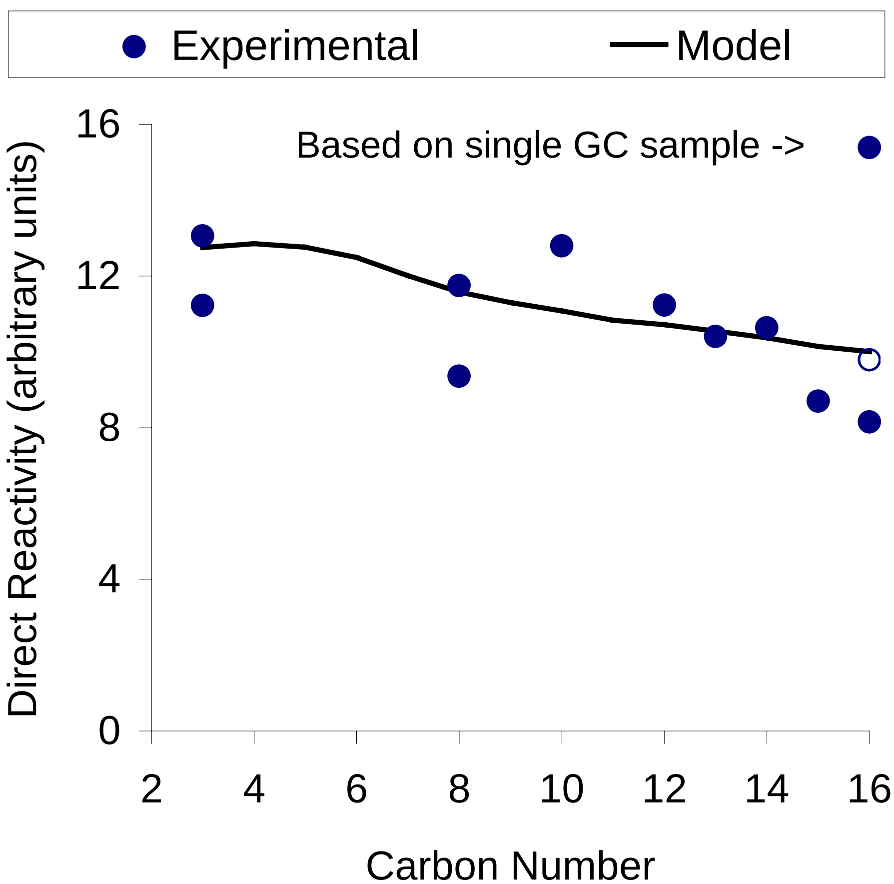
APPLICATION TO TEXANOL AND OTHER LOW VOLATILITY COATINGS MATERIALS

APPLICATION TO PETROLEUM DISTILLATES

APPLICATION TO WHOLE COATINGS EMISSIONS?

## CURRENT STATUS:

## DIRECT REACTIVITY MEASUREMENT RESULTS FOR NORMAL ALKANES



# REACTIVITY QUANTIFICATION FOR PETROLEUM DISTILLATES

## CURRENT STATUS

- PETROLEUM DISTILLATES ARE MAJOR COMPONENTS OF SOLVENT-BASED COATINGS
- FOLLOWING COMPOSITIONAL INFORMATION IS REQUIRED FOR REACTIVITY ESTIMATES:
  - ALKANE AND AROMATIC CONTENT
  - CARBON NUMBER DISTRIBUTION
  - NORMAL, BRANCHED AND CYCLIC ALKANE DISTRIBUTION
  - AROMATIC SPECIATION, IF APPLICABLE
- ESTIMATES CONSISTENT WITH CHAMBER DATA FOR THE FEW MIXTURES THAT WERE STUDIED. BUT **REPRESENTATIVENESS IS UNCERTAIN**.
- NECESSARY COMPOSITIONAL INFORMATION DIFFICULT TO OBTAIN AND OFTEN PROPRIETARY
- CARB STAFF DEVELOPED PROTOCOL FOR MAKING MIR ESTIMATES BASED ON LIMITED DATA
  - NOT EXPERIMENTALLY EVALUATED
  - BASED ON PROPRIETARY DATA
  - NO PROVISION FOR CHANGING OR UPDATING REACTIVITY SCALE.
  - NO PROVISION FOR COMPOSITIONAL UNCERTAINTY ANALYSIS.

# REACTIVITY QUANTIFICATION FOR PETROLEUM DISTILLATES

## PROPOSED PROJECT

- DEVELOP SPREADSHEET-BASED METHOD TO ESTIMATE REACTIVITY AND COMPOSITIONAL UNCERTAINTY FOR PETROLEUM DISTILLATES
  - ESTIMATES IN TERMS OF COMPOSITION SO ANY REACTIVITY SCALE CAN BE USED
  - ESTIMATES WHEN DATA LIMITED BASED ON AVAILABLE COMPOSITION DATA
  - UNCERTAINTY ESTIMATES WILL BE A FUNCTION OF AMOUNT OF INFORMATION
  - SPREADSHEET DOCUMENTED FOR USE BY INDUSTRY AND REGULATORS
- EVALUATE METHOD
  - COMPARING ESTIMATES WITH DETAILED COMPOSITION DATA WHERE AVAILABLE
  - COMPARING PREDICTED VS MEASURED DIRECT REACTIVITIES
  - COMPARING PREDICTIONS WITH CHAMBER DATA WHERE DATA AVAILABLE
- **INDUSTRY PARTICIPATION IS ESSENTIAL** TO OBTAIN NECESSARY INFORMATION
  - NEED TO DEVELOP PROCEDURES TO ALLOW USE OF PROPRIETARY DATA TO DEVELOP AND EVALUATE METHOD